

Learning How to Ride the Wind: The Disappointments and Potential of Wind Power in China

By Joanna Lewis

A visit to China's Nan'ao Island should be enough to convince anyone that wind turbines can be beautiful structures. Driving up the dirt roads to the turbine sites, one is greeted by tall, futuristic towers lining the ridges of the island's mountainous terrain and from the turbine site one can gaze down at the green island

and the surrounding bright blue ocean waters. Nan'ao is a window into another side of China providing a stark contrast to the smog-ridden urban centers—it is a coastal island community exporting clean electricity to the mainland.

China's total exploitable wind power resources are estimated to be around 250 gigawatts (GW).¹ If China develops even one-half of its conservatively

estimated wind resources it could generate around 275 billion kilowatt-hours of power each year, or about one-fifth the country's current demand (Lew and Logan, 2001). However, as of 2002, China's installed wind power capacity totaled 468 megawatts (MW), representing only a fraction of a percent of the total wind power potential (Electric Power Research Institute of China, 2001; American Wind Energy Association, 2002).

The Expectations:

Rapid Growth and Local Production

In the late 1990s, many energy analysts within China and abroad were predicting how China was likely to meet its target wind capacity for the year 2000 of 1,000 MW, and would easily meet, if not surpass, the 2005 target of

1500 MW (Zhang, Wang, Zhuang, Hamrin & Baruch, 2001; Lew & Logan, 2001). The chain of events to catalyze greater wind energy growth was expected to proceed as follows: the best available international wind power technology would be transferred to China, and the increased localization of wind turbine production would reduce the cost—by as much as 20 percent (Taylor & Bogach, 1998). The reduced price of the technology would result in increased demand for new wind farms, thereby expanding capacity throughout China. However, today with more wind projects cancelled than new projects sited, expectations are less optimistic. National targets for wind power in 2000 were not met, and it is even less likely that China will meet the target of 1,500 MW by 2010. Clearly this is a disappointing trend to all who were eagerly anticipating the escalation of China's wind industry.

The Disappointments:

Slow Growth and Continued High Costs

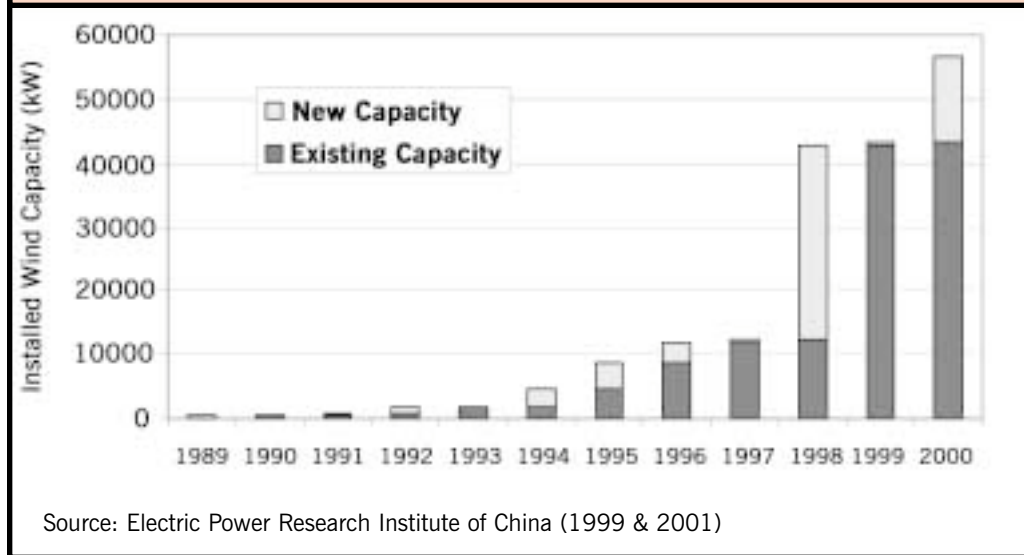
Since wind capacity did not increase as rapidly as both international experts and Chinese planners expected, it is important to examine what happened to interfere with this development. As planned, international wind power technology was transferred to China, and production has gradually become more localized—but not evenly across the industry. From the beginning, manufacturers in China created their own innovative small turbine design technology; conversely, producers of medium and large turbines began with technology imported from abroad (Lew, Williams, Xie, & Zhang, 1998). This pattern of foreign technology imports for Chinese wind farms has persisted and local manufacturers of medium and large turbines are still trying to capture a share in the market.

Local production of components for Chinese-foreign joint venture operations also is moving less rapidly than experts and planners had anticipated. Technology transfer programs initiated during the "Ride the Wind" (*Chengfeng*) Program in 1996 began with 20 percent local content with a goal of an increase to 80 percent as learning on the Chinese side progressed (Lew, 2000). The Guangzhou Institute of Energy Conversion asserts that China has "mastered" the manufacturing of the key components—derricks, generators, and gearboxes—and



Windmills in Operation on Nan'ao Island

Figure 1. Wind Power Capacity on Nan'ao Island



that “progress has been made” on the control system and on glass fiber components.² The Xinjiang Wind Energy Company reports that they have produced their own 600-kilowatt (kW) turbines with 78 percent local content.³ Exactly what components are being manufactured locally and how this shift has been able to impact the overall cost of the technology in China is not well documented and is a topic for future research.

Even if localization resulted in less expensive technology, this has yet to be reflected in either the cost or the price of wind power in China. Although many studies have estimated the cost of wind power in China, the actual cost is unclear. Electricity produced through wind power typically costs more than electricity from coal-fired power plants, particularly in provinces with abundant coal resources (including wind-rich Inner Mongolia). The cost of wind power reported by wind farm developers in China has been conspicuously steady throughout the 1990s rather than declining, as has been the case in wind power markets of other countries such as the United Kingdom (Liu, Lin & Zhang, 2002).

Either the cost of wind power is not falling as rapidly as had been anticipated, or the declining cost is not being reflected in the price of wind power. Regardless of the cause, the continued high cost of wind power has lowered the demand for new wind farms considerably. While some new projects are going forward in China,⁴ other projects that were expected to materialize have been rejected.⁵ Foreign investors and multilateral organizations expected that demand for wind power would be driven partially by local and central governments looking to cleaner electricity sources to mitigate urban air pollution. However, except in a few cases (such as Shanghai),

environmental protection does not appear to be the primary driver in wind power development.

Potential Wind Power “Hot Spots”

The overall situation for new wind farms in China appears grim. However, two places in China will be very important to watch over the next couple of years, as their experience with wind farm development could potentially “make or break” the future of grid connected wind farms in China.

Nan’ao

The island of Nan’ao located near the city of Shantou on China’s southeastern coast hosts the second largest wind farm in China, the largest concentration of wind power generation capacity in eastern China, and some of the best wind resources in the world (Zhang, Wang, Zhuang, Hamrin & Baruch, 2001). Wind power development was initially brought to Nan’ao by the local government for electrification of the island. The continued involvement of the local government in Nan’ao’s wind power industry has proved instrumental in the continued development of the island’s wind resources. Selling about 75 percent of the power produced by the island’s wind farms to the mainland has become a profitable industry that brings important revenue to the small island economy (U.S. Embassy Beijing, 1999). Unlike many of China’s large wind farms that are located in sparsely populated areas in western China with a relatively low demand for electricity, the location of wind farms in Nan’ao on China’s southeastern coast places it close to electricity demand.

Part of the reason investment in wind projects on Nan’ao has been so successful is due to a series of low-interest loans from foreign governments hoping to

promote their wind technology in China. Even without this benefit, the high cost of electricity in Guangdong province makes wind a competitive source of electricity,⁶ particularly when compared with the cost of other alternatives, such as hydropower from large plants in Yunnan province or locally produced nuclear power. Around 56 MW of wind power capacity is currently operating in Nan'ao (see Figure 1), with much of the island's remaining undeveloped land sited for wind farm development in the near future.

Shanghai

Two wind projects are planned for Shanghai and scheduled for completion by the end of 2003—a 6 MW project in Nanhui and a 14 MW project on Chongming Island. These projects, totaling 20 MW, are the only remaining component of what was initially a World Bank/Global Environment Facility (GEF) project consisting of 190 MW of wind capacity in four provinces that, along with Shanghai, included Inner Mongolia, Hebei, and Fujian.⁷ The support of the Shanghai municipal government was apparently crucial to the project's survival. Shanghai municipal leaders stated their motivations to support the project include “a desire to be seen as a modern, cosmopolitan and green city.” Moreover, this wind project would be a highly visible demonstration project that would both “provide evidence of the municipality's environmental objectives” and promote the development of “a wind equipment supply industry”

(World Bank, 2001). Both the Nan'ao and Shanghai wind projects have benefited from entrepreneurial local governments that recognized the benefit that wind power development could bring to their region.

Shanghai is quite similar to Nan'ao in terms of its wind resources and coastal island geography, and both sites have a capacity factor for power output of about 25 percent. (See Table 1). In addition, both Shanghai and Guangdong have some of the highest electricity prices in China.⁸ The construction of a transnational west-east pipeline from Xinjiang to Shanghai means that the primary source of new electric generation capacity being considered for Shanghai is natural gas-fired power plants. Many believe the cost of natural gas from this pipeline will be much higher than original projections due to underestimates of construction costs for the pipeline and associated distribution networks (“China's Big Bet on Gas,” 2002).

Shanghai and Nan'ao may be leading the way for future wind power development in China. Nan'ao has already been recognized as China's wind power development “success story” (U.S. Embassy Beijing, 1999). Recently, policymakers in Hong Kong—comprised of islands with geography and wind resources similar to those of Nan'ao—have been looking to Nan'ao to aid in making decisions about developing their own wind resources.⁹ The decision to promote the development of Shanghai's wind resources may very likely have been influenced by Nan'ao's success.

Table 1. Nan'ao and Shanghai Wind Power Comparisons

	Total Wind Capacity	Average Annual Wind Speed	Annual Power Generation	Capacity Factor ^c
Nan'ao ^a	56.78 MW	7.0-7.5 m/s at 30 m	~124 GWh/year	~25 percent
Shanghai ^b	20 MW	7.5 m/s at 50 m	44.6 GWh/year	~25 percent

^aAnnual power generation and capacity factor are extrapolated from power output data for two wind farms on Nan'ao totaling two-thirds of the island's total capacity.¹

^bThe Shanghai wind farm is planned for construction in 2003. All wind farm figures are therefore estimates (SETC/GEF, 2001).

^cCapacity Factor (CF) is the actual or predicted output as a percent of installed capacity. Although many calculations estimating power output from future wind farms assume a 30 percent CF, in most cases this is significantly above the average achieved. See for example “Generating Capacity Factors for UK Wind Power Stations” <www.cprw.org.uk/wind/winstat.htm>. U.S. Department of Energy reports the “capacity factor for a wind farm ranges from 20 to 35 percent” <http://www.eren.doe.gov/femp/techassist/wind_energy.html>.

TABLE NOTES

¹ For one Nan'ao wind farm, the capacity factor was predicted by the developer to be 37 percent. However wind farm data shows that in 6 years of operation, the highest annual Capacity Factor (CF) was 35 percent, and the average CF over the 6 years was 27.8 percent (Source: personal data collection in Nan'ao, 2002).

Successful wind development in Shanghai could have powerful implications for promoting wind power development in China's coastal region. As stated in the World Bank/GEF project justification document:

The Shanghai wind farms would demonstrate the viability of wind power in China's coastal regions, where wind resources are very good and costs of conventional alternatives high....As such, assisting Shanghai develop its wind potential will have high payoffs by helping to reduce the perceived risks. Other provinces would be then more inclined to follow suit (World Bank, 2001: p.2 memorandum; p.4 attachment).

There is currently an opportunity for China to use other eastern coastal sites, offshore islands, and even offshore ocean sites for additional wind farm development. The U.S. Department of Energy, the National Renewable Energy Laboratory, and the U.S. Environmental Protection Agency completed a wind resource assessment and mapping of southeastern China in 1998 that identified 47 GW of wind development potential in the provinces of Jiangxi, Fujian, and the eastern half of Guangdong.¹⁰ China's eastern coastal region is expected to be a prime site for offshore wind development, with easily exploitable offshore areas along the east China coastline at a water depth between 2 and 15 meters estimated to have a minimum of 750 MW of resource potential (Shi, 2000).¹¹

The increased decentralization of political authority in China has given provincial and local governments an increased ability to make decisions about electric power technology options and to incorporate regional and local motivations and incentives. The Nan'ao and Shanghai cases illustrate how local government support may be crucial for future wind power development in China. Moreover, local governments may recognize that the environmental benefit of substituting future fossil fuel generation initiatives with coastal and offshore wind development would be so large that even in the face of seemingly adverse political conditions, wind power is not something to be overlooked in planning for China's energy future.

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ENDNOTES

¹ This is an estimate at a 10-meter hub height (http://www.nrel.gov/china/wind_energy.html). Since wind resources increase with height this estimate would likely be greater at a standard tower height of around 50 meters.

² Guangzhou Institute of Energy Conversion (under the direction of State Ministry of Science & Technology, State Economic & Trade Commission, and Chinese Academy of Sciences). http://www.newenergy.org.cn/english/wind/science/progress_windpower.htm

³ Xinjiang Wind Energy Company Web site. <http://www.xjwind.com>

⁴ Projects moving forward include the Asian Development Bank/Global Environment Facility project for three wind farms in Xinjiang, Heilongjiang, and Liaoning provinces, totaling 78 MW (ADB, 2000).

⁵ The World Bank/Global Environment Facility project eliminated wind farms in three out of four proposed sites, totaling 170 MW (World Bank, 2001).

⁶ Guangdong Province electricity rates are approximately 0.6 Yuan/kWh. (Lawrence Berkeley National Laboratory, *China Energy Databook*, 2001)

⁷ It was requested by the China Ministry of Finance that these wind farms be deleted from the project (World Bank, 2001, p.2). It is believed that this was in large part due to the uncertainties surrounding the restructuring of the power sector, as well as inadequate government policies (World Bank, 2001, p.3).

⁸ Shanghai Municipality electricity rates range from 0.612 for residential consumers to 0.776 for industrial consumers. (*China Price Yearbook*, 1998).

⁹ For more information see FoE (HK) article: "Wind Power Hong Kong 2002" Seminar [On-line]. Available: <http://www.ecc.org.hk/3emarinfo9.htm> and Lu et. al, 2002

¹⁰ http://www.nrel.gov/china/wind_energy.html

¹¹ Wind resource is estimated at a height of 10 meters.